REMARKS

Favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

As recognized by the Examiner, the present application is an U.S. national stage of an International application filed originally in Japanese. An English translation of the original Japanese text was filed on August 1, 2001.

Applicant has now discovered several inadvertent translational errors in the English translation. These errors are corrected above. Specifically, the specification on pages 5 and 6 have been amended to correct the recitation of "alkylphenylether" to "alkylether". Support for the amendment is found in the specification at page 9, lines 24-26. The specification has also been amended to insert the formulas for the polyoxyethylene alkylethers identified as RT610 discussed on pages 5 and 6 of the English text. Support for the formulas is found in the Japanese text of the original international application, a copy of which is enclosed as published application WO 01/46494. See claims 2 and 7 of the original Japanese text. Please note that during preparation of the translation, it is believed that the names and structures of the compounds used in this invention, i.e. polyoxyethylene alkylether phosphoric acid and polyoxyethylene alkylether (RT610), were apparently confused by the translator with the names and structures of the prior art compound discussed on pages 3-4 of the specification, i.e. polyoxyethylene alkylphenylether phosphoric acid and polyoxyethylene alkylphenylether identified as RE610. For the Examiner's information, there is also a copy of the Japanese priority application, which application further supports the formulas inserted into the specification.

Claims 10-17 have been cancelled without prejudice and replaced with new claims 18-32.

New claim 18 is supported by original claims 5, 6, 10 and 12, and in the specification at page 2, line 24 to page 4, line 1, and on page 7, lines 10-21.

New claim 19 is supported by the specification at page 3, lines 12-27. New claims 20-23 are supported by original claim 11. New claims 24-26 are supported by original claim 8. New claim 27 is supported by page 5, lines 19-25. New claim 28 is supported by the original Japanese text of the international application. New claims 29-32 are supported by original claim 9.

Turning to the Official Action, in item 2, the Examiner states that JP 61-227176 cited in the IDS filed August 1, 2001 has not been considered because an English Abstract has not been submitted. The Examiner's position is incorrect. Under U.S. rules, the Examiner is required to consider this reference, because it has been cited in the International Search Report, and the relevance of the reference is indicated in the Search Report. See MPEP 609, particularly page 600-122, right column and MPEP 1893.03(g). Reconsideration is respectfully requested.

Regarding item 3, a proposed drawing correction is submitted concurrently herewith under separate cover letter.

Regarding item 6, this ground of rejection is deemed to be overcome in view of the cancellation of claim 10 and the presentation of the new claims.

Regarding item 8, claims 10-14 are rejected under 35 USC 102 as being anticipated by Endo et al. This ground of rejection is deemed to be overcome in view of the cancellation of such claims and the wording of the new claims presented.

Endo et al. disclose depositing a palladium layer 27 on a TiN layer 26 as a barrier layer on a semiconductor substrate 21, polishing the palladium layer 27 by CMP, and selectively embedding silver into a contact hole 23 and a wiring grooves 24 by electroless plating (see page 8, lines 5-19; FIGS. 4(a) - 4(c)).

In contrast thereto, a method according to the present invention basically utilizes electrolytic plating to form a copper interconnection on a substrate. Specifically, a seed layer, which is the same metal as metal to be plated, is formed on a substrate, and then metal is embedded into a recess by electrolytic plating with the seed layer serving as an electrode. As a design rule (wiring width) is reduced from 0.18 μm to 0.10 μm, it is difficult to form a complete seed layer on a substrate. Therefore, according to the present invention, an auxiliary copper layer for reinforcing a seed layer is formed by electroless plating. Thus, electroless plating is not utilized for embedding copper into a recess, but for forming an auxiliary copper layer for reinforcing a seed layer.

When a design rule is reduced from 0.18 μm to 0.10 μm, it is difficult to form a complete seed layer on a substrate. An incomplete seed layer causes voids to be generated in a copper interconnection. A method according to the present invention prevents these drawbacks. Specifically, a method according to the present invention has features that an auxiliary copper layer for reinforcing a seed layer is formed by electroless plating at a plating rate of 50 nm/min or less to form a uniform seed layer on a substrate. In this manner, voids are prevented from being generated.

In summary, the cited reference fails to disclose or suggest the method according to the new claims. First, Endo et al. fails to disclose a method according to claim 18, including a step of forming an auxiliary copper seed layer for reinforcing the copper seed layer within the recesses using an electroless copper plating liquid. Second, Endo et al. fails to disclose or suggest a method according to claim 18, which includes a step of filling copper in the recesses by an electrolytic plating process using the reinforced copper seed layer as a current feeding layer.

As described above, the present invention is believed to be patentable over Endo et al.

Claims 5-6 are rejected under 35 USC 103 as being unpatentable over Endo et al. in view of Shin. This ground of rejection is also respectfully traversed as applied to the wording of the new claims.

Shin was published on June 30, 2000, which is after the priority date of the present application, i.e. December 22, 1999. This reference is removed as prior art under 35 USC 119, by submission of an English translation of the priority application. A certified copy of the priority application is believed to be of record in this national stage application. Accordingly, since the priority document supports the claimed subject matter under 35 USC 112, the rejection is deemed to be removed.

Endo et al. alone fail to disclose the subject matter of the rejected claims, for the reasons stated above.

Lastly, claims 7 and 15 are rejected under 35 USC 103 as being unpatentable over Endo et al. in view of Shin and further in view of Kikuchi et al.

This ground of rejection is also deemed to be traversed by removal of Shin as prior art.

Furthermore, it should be noted that Endo et al. would fail to render obvious either claims 5-9 or new claims 18-32, taken alone or with Kikuchi et al. The claimed methods require forming an auxiliary copper seed layer for reinforcing the copper seed layer within the recesses using an electroless copper plating liquid, and then filling copper in the recesses by an electrolytic plating process using the reinforced copper seed layer as a current feeding layer. Neither Endo et al. nor Kikuchi et al. teach or suggest forming a copper interconnection employing these two steps.

In view of the foregoing, it is believed that each ground of rejection set forth in the Official Action have been overcome. Accordingly, favorable reconsideration and allowance is respectfully solicited.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Page 5, lines 19-25, please replace the paragraph with the following rewritten paragraph:

The electroless copper plating liquid should preferably further contain polyoxyethylene [alkylphenylether] alkylether phosphoric acid, polyoxyethylene [alkylphenylether] alkylether, and a mixture of polyoxyethylene [alkylphenylether] alkylether phosphoric acid and polyoxyethylene [alkylphenylether] alkylether (e.g., RT610 manufactured by Toho Chemical Industry Co., Ltd.), indicated below, at a concentration ranging from 1 to 100 mg/L:

(polyoxyethylene alkylether phosphoric acid)

$$[RO(C_2H_4O)_n]_m - \underset{\underset{O}{\|}}{P} - (OH)_{3-m}] \quad m = 1 \text{ through } 3$$

(polyoxyethylene alkylether)

$$RO(C_2H_4O)_nH.$$

Page 6, lines 11-27, please replace the paragraph with the following rewritten paragraph:

Since the electroless copper plating liquid contains polyoxyethylene [alkylphenylether] alkylether phosphoric acid, polyoxyethylene [alkylphenylether] alkylether, and a mixture of polyoxyethylene [alkylphenylether] alkylether phosphoric acid and polyoxyethylene [alkylphenylether] alkylether, the plating rate is [made] lower than the plating rate of the conventional plating process, allowing the thickness of the plated film to be controlled with ease. Specifically, when the plating rate is lowered, a time margin is achieved in the plating process to provide freedom for the design of the plating process and apparatus. This advantage manifests itself particularly in the formation of thin films. While the plating rate for such an application is usually 100 nm/min. or lower, the plating rate may be reduced to 50 nm/min. or lower. Inasmuch as the lower plating rate gives a good film thickness controllability, the electroless copper plating liquid is suitable for use in forming copper interconnections on semiconductor substrates.